Assessment and Development of Antimicrobial Coated Steels for Indoor Use

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1. Introduction:

The COVID-19 pandemic, as well as the rise in healthcare associated infections (HCAIs) and multi-drug resistant bacteria, have sparked a heightened interest into infection prevention control measures. Studies have shown there is a link between contaminated surfaces and infection transmission rates, with some bacteria surviving for months at a time. Antimicrobial coatings have been shown to aid in the reduction of transmission and are the focus of this PhD project.

2. Why antimicrobial coatings?

- Antimicrobial coatings offer a cost-effective solution to aid with the prevention of, and protection from, infection-causing microbes[1]
- They offer enhanced protection against microbes compared with untreated surfaces
- Safer to both humans and the environment compared with disinfectants[2]
- Antimicrobial resistance was already a public health concern, and the COVID-19 pandemic has increased interest into reducing transmission[3]
- Within the global antimicrobial coatings market, an estimated incremental growth of £552.31M is expected between 2019 and 2024[4]

3. Aims

- To use current industry standards to assess various antimicrobial coatings
- To determine the impact of cleaning products and hand sanitizers on antimicrobial coatings
- To formulate and assess an antimicrobial coating that is comparative to industry benchmarks

4. How do antimicrobial coatings work?

- Antimicrobial coatings are surface modifications - typically either physical or chemical, and can work through different mechanisms:

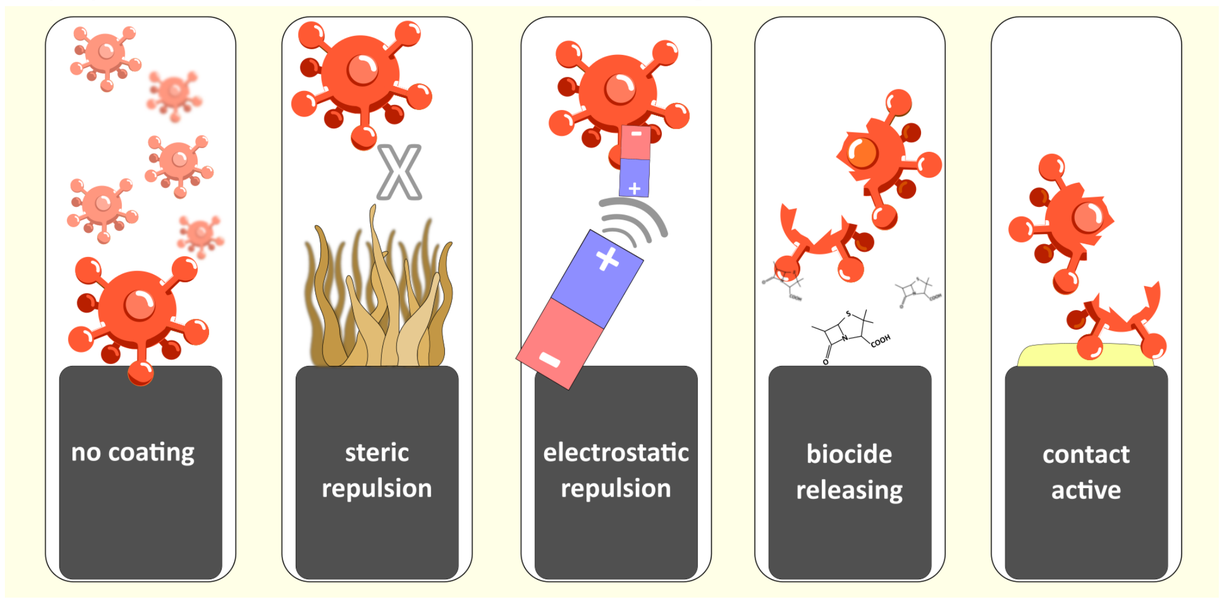

Figure 1: Mechanisms of action for antimicrobial coatings. Image courtesy of Phil Jemmet, WMG Outreach.

- Some of the most commonly used antimicrobial additives within coatings include: copper, silver, or nanoparticles. These can also work in different ways:

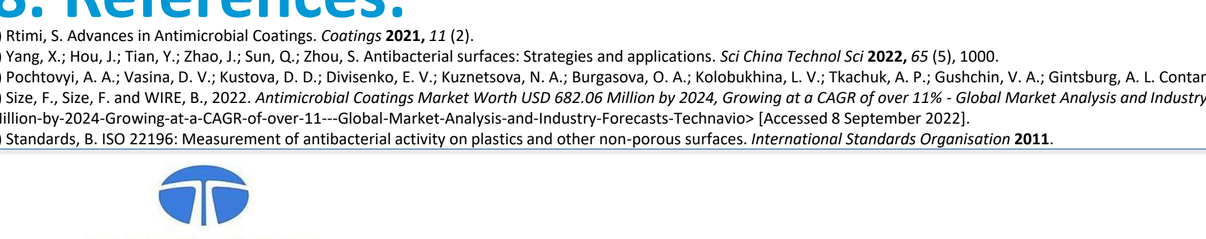

Figure 2: potential mechanism of action for silver ions against bacteria

5. How are antimicrobial coatings tested?

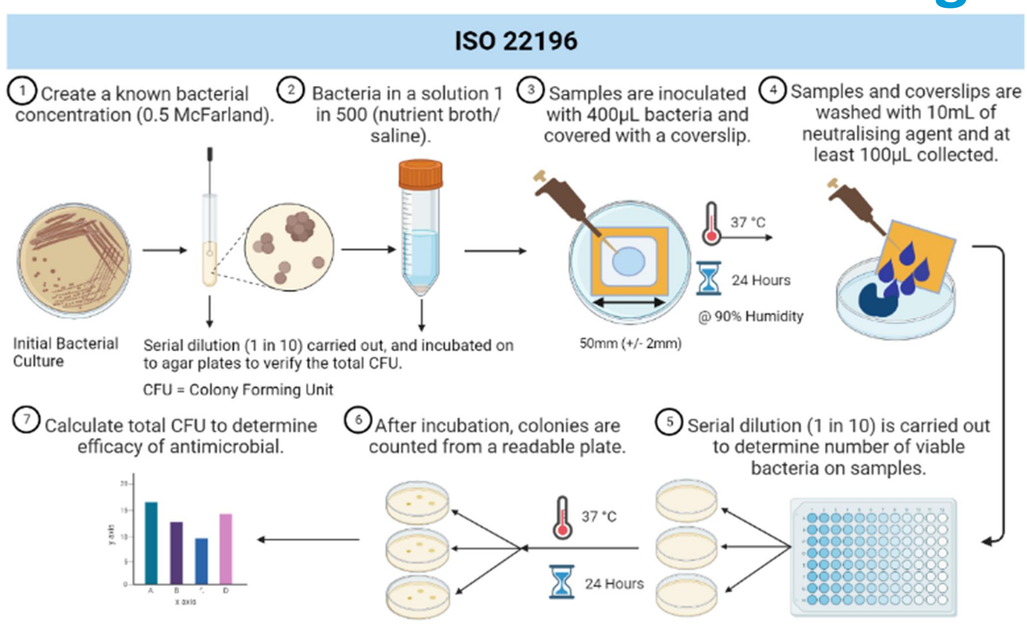

Figure 3: ISO 22196: assessment of antibacterial activity for non-porous and plastic surfaces.[5] Created with Biorender.com

6. Results

- Log reduction in bacterial growth across all samples were calculated to determine any significant changes in bacterial growth (4 log reduction = strong antimicrobial activity)
- Only *Escherichia coli* was calculated, due to inconsistencies in *Staphylococcus aureus* growth.

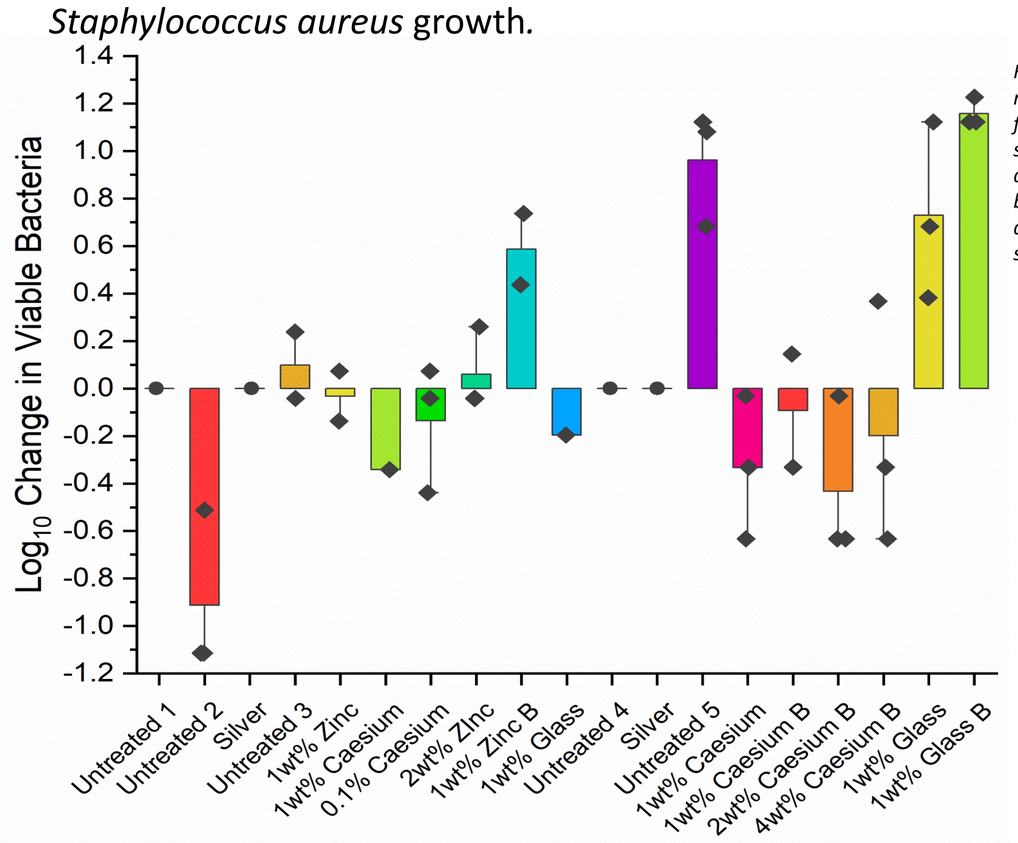

Figure 4: Log reduction in growth for E.coli for all samples tested. Circle dots indicate no bacterial data was available for that sample.

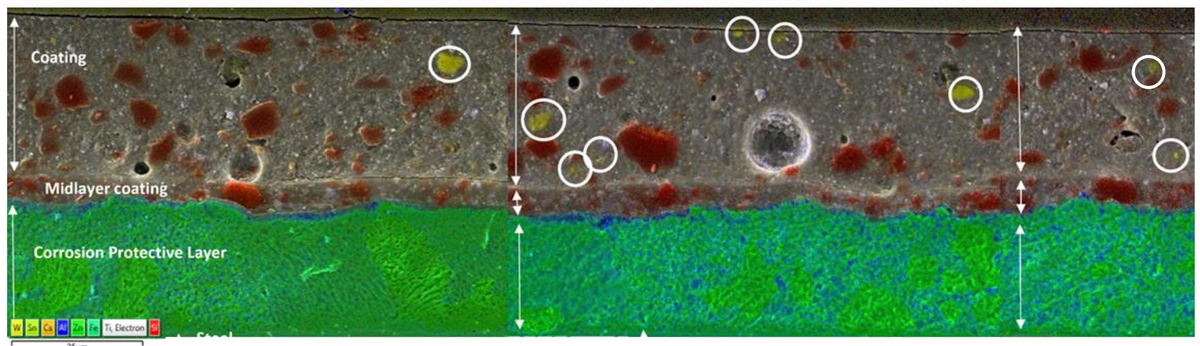

Figure 5: EDX layered SEM image of a cesium-based coating, circled spots show agglomeration containing cesium, tungsten and tin.

Agglomerations (circled) across the coating show inconsistent patches of varying sizes and depths within the coating.
- This reduces availability of active sites to bacteria and can impede antibacterial activity.

7. Summary and future work:

- The COVID-19 pandemic and rise in HCAIs and multi-drug resistance bacteria has sparked a heightened interest into antimicrobial coatings
- Antimicrobial coatings will help in reducing transmission rates and thus reduce the financial burden, associated with HCAIs
- Initial findings from ISO 22196 have been unable to confirm significant antimicrobial activity
- Agglomerations of the nanocomposite/nanoparticle additives could impede potential performance as an antimicrobial

8. References:

1) Rtimi, S. Advances in Antimicrobial Coatings. *Coatings* **2021,** *11* (2).
2) Yang, X.; Hou, J.; Tian, Y.; Zhao, J.; Sun, Q.; Zhou, S. Antibacterial surfaces: Strategies and applications. *Sci China Technol Sci* **2022,** *65* (5), 1000.
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4) Size, F., Size, F. and WIRE, B., 2022. *Antimicrobial Coatings Market Worth USD 682.06 Million by 2024, Growing at a CAGR of over 11% - Global Market Analysis and Industry Forecasts | Technavio*. [online] Businesswire.com. Available at: <https://www.businesswire.com/news/home/20201103005552/en/Antimicrobial-Coatings-Market-Worth-USD-682.06-Million-by-2024-Growing-at-a-CAGR-of-over-11---Global-Market-Analysis-and-Industry-Forecasts-Technavio> [Accessed 8 September 2022].
5) Standards, B. ISO 22196: Measurement of antibacterial activity on plastics and other non-porous surfaces. *International Standards Organisation* **2011**.